

CLAIMS

In the following, the patent claims will be given, and the various details of the invention may show variation within the scope of the inventive idea defined in said claims and differ from what has been stated above for the sake of example only.

What is claimed is:

Pub. A1
~~1. A method for reducing the tendency of paper to curl in a drying section of a paper machine, comprising drying a paper web having opposed bottom and top sides by pressing the bottom side of the web against heated faces of a plurality of drying cylinders in the drying section of a paper machine,~~

~~after the bottom side of the web separates from the heated face of a drying cylinder, raising the temperature of the bottom side of the web by applying a sufficient amount of steam onto the bottom side of the web to control the moisture gradient in the thickness direction of the paper web between the paper web sides in a steam treatment onto the entire width of the paper web in the drying section such that tensions that have been formed or that tend to be formed in the fiber mesh are relaxed by means of heat and moisture from the steam in the area of their formation or thereafter,~~

~~said steam treatment being applied to an open face of the bottom side of the paper web as it runs on a wire in a suction sector of a suction roll or cylinder in said drying section and in an area of said drying section where the dry solids content of the paper web is from about 70 to about 98 percent, and promoting the penetration of said steam treatment into the paper web in a direction of the thickness of the paper web by means of suction present on said suction sector, to thereby control curling of the web.~~

2. The method of claim 1, further comprising applying said steam treatment at an end of the drying section.

3. The method of claim 1, further comprising applying said steam treatment in an area of said drying section where the dry solids content of the paper web is from about 80 to about 95 percent.

4. The method of claim 1, further comprising providing said drying section with groups of drying cylinders with single-wire draw, arranging said drying cylinders in an upper row, and arranging said suction roll or cylinder in a lower row, such that paper broke can be removed directly through open intermediate spaces located underneath said drying cylinders.

5. The method of claim 1, further comprising blowing air into spaces defined between the wire and said suction roll or cylinder.

Sub A2

~~6. A drying section of a paper machine, comprising~~
at least one drying section group comprising a plurality of drying cylinders for drying a paper web having opposed bottom and top sides, said drying cylinders each having a heated surface,
a drying wire running in a meandering fashion over said drying cylinders, said drying wire pressing the bottom side of the paper web against said heated surfaces of said drying cylinders,
at least one steam box arranged in said drying group and comprising a counter-face which, together with a free face of the paper web, defines a contact-free steam-treatment gap in said drying group, said steam box extending substantially across an entire transverse width of the paper web,
said steam box being positioned in a location after the bottom side of the web has separated from one of said heated surfaces of said drying cylinders and applying steam onto the bottom side of the web to raise the temperature of the bottom side of the web and control a moisture gradient in a direction of thickness of the paper web between the paper web sides substantially across an entire width of the paper web such that tensions that have been formed or that tend to be formed in the fiber mesh of the paper web are relaxed by means of heat and moisture in the area of their formation or substantially immediately thereafter, and said steam box applying steam to the paper web during the run of the paper web on a wire through the drying section the tendency of the paper web to curl is prevented in the run of the paper web through the drying section

7. The drying section of claim 6, wherein said steam box further comprises regulating means, said regulating means controlling the quantity of steam supplied by the steam box across the transverse width of the paper web.

8. The drying section of claim 7, wherein said steam box is arranged in an area of said drying section where the dry solids content of the paper web is from about 80 to about 95 percent, by weight.

9. The drying section of claim 6, wherein said drying group further comprises a plurality of wire guide rolls and/or leading cylinders over which the paper web runs, at least one of said wire guide rolls or leading cylinders being a suction-leading cylinder provided with negative pressure, said steam box being placed in an area of said drying section having a single-wire draw on a suction zone of said suction-leading cylinder, such that the negative pressure prevailing in interior spaces of said suction-leading cylinder supports the paper web and promotes the action of the steam on the paper.

10. The drying section of claim 9 which comprises at least two drying section groups, at least one guide roll located in a gap between said drying group sections for guiding the paper web, said steam box being fitted opposite said guide roll.

11. The drying section of claim 9, wherein said drying section group has a single-wire draw in which steam is applied to the paper web running on the wire, said drying cylinders being arranged in an upper row and said wire guide rolls and/or leading cylinders being arranged in a lower row below said drying cylinders.

12. The drying section of claim 11, wherein said drying section groups comprise a plurality of additional steam boxes fitted in connection with additional ones of said leading cylinders and/or said wire guide rolls.

13. The drying section of claim 9, wherein said suction-leading cylinder has an interior portion and an outer perforated and grooved mantle, whereby suction in the interior of said suction-leading cylinder is spread onto a circumference of said suction-leading cylinder to thereby promote penetration of steam into the paper web.

14. The drying section of claim 9, further comprising blow boxes for blowing air into spaces defined between said drying wire and said leading cylinders.

15. The drying section of claim 9, further comprising at least one inverted drying section group in which drying cylinders are arranged in a lower row and wire guide rolls and/or leading cylinders are arranged in an upper row above said drying cylinders, said at least one inverted drying section group being arranged adjacent to said at least one drying section group.

16. The drying section of claim 15, wherein the web is transferred from a wire in said at least one drying section group to a wire in said at least one inverted drying section group as a closed draw.

17. The drying section of claim 6, wherein said steam box is arranged in an area of said drying section where the dry solids content of the paper web is from about 70 to about 98 percent, by weight.

Pub 23
~~18. A method for reducing the tendency of paper to curl in a drying section of a paper machine, comprising drying a paper web having opposed top and bottom sides by pressing the bottom side of the web against heated faces of a plurality of drying cylinders in the drying section of a paper machine, applying a sufficient amount of steam onto the bottom side of the web to control the moisture gradient in the thickness direction of the paper web between the paper web sides in a steam treatment onto the entire width of the paper web in the drying section such that tensions that have been formed or that tend to be formed in the fiber mesh are relaxed by means of heat and moisture from the steam in the area of their formation or thereafter, arranging said drying cylinders in an upper row and a lower row.~~

Pub A3

~~arranging suction rolls or cylinders in gaps between said drying cylinders in said upper row and said lower row, applying said steam treatment to a free draw of the paper web located between said upper row and said lower row of said drying cylinders, and applying steam onto at least one side of the paper web, to thereby control curling of the web.~~

19. The method of claim 18, further comprising applying said steam treatment in an area of said drying section where the dry solids content of the paper web is from about 70 to about 98 percent.

20. The method of claim 18, further comprising applying said steam treatment in an area of said drying section where the dry solids content of the paper web is from about 80 to about 95 percent.

21. The method of claim 18, further comprising applying said steam treatment at an end of the drying section.

22. The method of claim 18, further comprising carrying the web on a wire around said drying cylinders and said suction rolls or cylinders such that the wire runs in a meandering fashion over said drying cylinders and said suction rolls or cylinders and blowing air into spaces defined between the wire and said suction rolls or cylinders.

23. The method of claim 18, further comprising arranging a first steam box to apply steam onto a first side of the web in the free draw and arranging a second steam box to apply steam onto an opposite side of the web in the free draw.

Pub A4

~~24. A method for reducing the tendency of paper to curl in a drying section of a paper machine, comprising drying a paper web having opposed top and bottom sides by pressing the bottom side of the web against heated faces of a plurality of drying cylinders in the drying section of a paper machine, after the bottom side of the web separates from the heated face of a drying cylinder, raising the temperature of the bottom side of the web by applying a sufficient amount of steam onto the bottom side~~

Sub A4

~~of the web to control the moisture gradient in the thickness direction of the paper web between the paper web sides in a steam treatment onto the entire width of the paper web in the drying section such that tensions that have been formed or that tend to be formed in the fiber mesh are relaxed by means of heat and moisture from the steam in the area of their formation or thereafter, said steam treatment being applied to an open face of the bottom side of the paper web as it runs on a wire in a suction sector of a suction roll or cylinder located at an end of said drying section, and promoting the penetration of said steam treatment into the paper web in a direction of the thickness of the paper web by means of suction present on said suction sector, to thereby control curling of the web.~~

25. A method for reducing the tendency of paper to curl in a drying section of a paper machine, comprising:
drying a paper web having opposed top and bottom sides by pressing the bottom side of the web against heated faces of a plurality of drying cylinders in the drying section of a paper machine,
after the bottom side of the web separates from the heated face of a drying cylinder and the temperature of the bottom side decreases to a temperature below the temperature of the top side of the web, raising the temperature of the bottom side of the web to a temperature above the temperature of the top side of the web by applying steam onto the bottom side of the web to thereby control the moisture gradient in the thickness direction of the paper web between the paper web sides such that tensions that have been formed or that tend to be formed in the fiber mesh are relaxed by means of heat and moisture from the steam in the area of their formation or thereafter, and
said steam treatment being applied to an open face of the bottom side of the paper web as it runs on a wire in said drying section.

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Sub A4 26. A method of reducing the tendency of a paper web to curl in a paper machine, comprising the steps of:

asymmetrically drying the paper web in its thickness direction to a solids content at which curl-inducing stresses have been formed or tending to be formed in a fiber mesh of the paper web; and

subsequently applying sufficient moisture to the asymmetrically dried paper web to relax said stresses in the fiber mesh of the paper web, to thereby control curling of the web.

27. The method of claim 26, wherein the step of asymmetrically drying the paper web includes passing the paper web through a plurality of normal dryer groups, each of said plurality of normal dryer groups including a single tier of dryer cylinders, a plurality of guide rolls disposed below and between said dryer cylinders, and a single-wire draw so that only one side of said web engages said dryer cylinders.

Sub A5 28. The method of claim 27, wherein said guide rolls are suction cylinders.

29. The method of claim 26, wherein said moisture is in the form of steam condensate.

Sub A2 30. The method of claim 26, wherein said moisture is applied across the entire width of the paper web.

Sub B6 30
~~31. The method of claim 26, wherein said moisture is applied to said~~
stressed web immediately downstream of the location where said stresses are formed or
likely to be formed.

32. The method of claim 26, wherein said stresses in said fiber mesh of the
paper web are formed or likely to be formed at a solids content of at least about 70%.

33. The method of claim 27, wherein said moisture is applied to the side of
the web not engaging said dryer cylinders.

34. A paper machine, comprising:
means for asymmetrically drying the paper web in its thickness
direction to a solids content at which curl-inducing stresses have been formed or tending to
be formed in the paper web; and
means for applying moisture to the asymmetrically dried paper web for
relaxing said stresses to thereby control curling of the web.

~~35. The paper machine of claim 34, wherein said means for asymmetrically~~
drying comprises a plurality of normal dryer groups, each of said plurality of normal dryer
groups including a single tier of dryer cylinders, guide rolls disposed below and between
adjacent dryer cylinders, and a single-wire draw so that only one side of said web engages
said dryer cylinders

33

Sub C5

36. The paper machine of claim 34, wherein said means for applying moisture is disposed immediately downstream of said plurality of normal dryer groups.

37. The paper machine of claim 34, wherein said means for applying moisture extends across the entire width of the paper web.

Sub A7

38. The paper machine of claim 35, wherein said guide rolls are suction cylinders.

39. The paper machine of claim 34, wherein said stresses in said fiber mesh of the paper web are formed or likely to be formed at a solids content of at least about 70%.

Sub C6

40. The paper machine of claim 34, wherein said means for applying moisture includes a steam box.

41. The paper machine of claim 34, wherein said moisture is applied to the side of the web not engaging said dryer cylinders.